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Indian Standard

CODE OF PRACTICE FOR
CANAL OUTLETS

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Indian Standard

CODE OF PRACTICE FOR CANAL OUTLETS

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Indian Standard

CODE OF PRACTICE FOR CANAL OUTLETS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 23 February 1976, after the draft finalized by the Canals and Canal Linings Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Various types of canal outlets have been evolved from time to time to obtain suitable performance. No one type has come out to be suitable universally. In fact it is very difficult to achieve good design with respect to 'flexibility' and 'sensitivity' because of various indeterminate conditions both in distribution channels and the water course, namely, discharge levels, silt charge, capacity factor, rotation of channels, regime condition of distributing channel, etc. Variation in any of these factors affects proper working of an outlet. Even a particular type of outlet considered suitable upstream of a control structure in a channel may not remain suitable for a considerable distance on the same channel.

However, the information collected on the subject indicates that pipe outlet, both of non-modular type and semi-modular type, depending upon method of installation and open flume outlets and Crump's adjustable proportional module of semi-modular type has generally been adopted in the country. This standard has been prepared to give general guidance in respect of selection and installation of these outlets on irrigation channels.

0.3 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers general classification of outlets installed on irrigation channels and gives general guidance for selecting and installing non-modular and semi-modular outlets.

*Rules for rounding off numerical values (*revised*).

2. TERMINOLOGY AND NOTATIONS

2.0 For the purpose of this standard, the following definition shall apply.

2.1 Outlets — A device through which water is released from a distributing channel into a water course (cultivators' channel). The discharge through an outlet is usually less than 0.085 cumecs.

2.2 Notation — Unless otherwise stated, the following notations have been used in the formulae given in 5 and 6.

q = Discharge in cumecs of an outlet

A = Cross-sectional area of pipe in cm^2

H = Difference of water levels in the distributing channels and water course in metres

g = Acceleration due to gravity in m/s^2

B_t = Width of throat of weir in an outlet in metres

H_s = Head measured from F. S. L. in the distributing channel to the crest of outlet (H) minus depth of orifice r in m.

D = Depth of water in distributing channel in m

Cumecs = Cubic metres per second

W = Setting forward of the d/s wing wall of the approach

Q = Discharge in cumecs of a distributary channel upstream of the outlet

k = Ratio between the mean velocity for the entire distributing channel and mean velocity in the part of the distributing channel, wherein outlet is to be installed.

B_u = Bed width of the distributary channel upstream of the outlet.

3. CLASSIFICATION OF OUTLETS

3.1 Outlet may be classified in the following three types:

- a) *Non-modular Outlets* — Non-modular outlets are the outlets whose discharge is a function of the difference in water levels in the distributing channel and the water course and variation in either affects the discharge.

These outlets consist of rectangular or circular openings and pavement. The effect of downstream water level is more with short pavement, although even with long pavement it cannot be entirely eliminated.

- b) *Semi-modular Outlets* — Semi-modular outlets are the outlets whose discharge although depending on the water level in the distributing channel, is independent of the water level in the water course so long as the minimum working head required for their working is available.
- c) *Modular Outlets* — Modular outlets are the outlets whose discharge is independent of the water levels in the distributing channel and the water course, within reasonable working limits. This type of outlets are either with moving parts or without moving parts. In the latter case these are called as rigid modules.

Modular outlets with moving parts are not simple to design and construct and are, thus, expensive. These are liable to derangements due to increase in friction, rusting of the moving parts and any obstruction in the working of moving parts caused by the silt and weeds carried in flowing water.

4. GENERAL REQUIREMENTS FOR OUTLETS

4.1 An outlet shall be strong and shall not have moving parts liable to derangements or requiring periodic attention.

4.2 Interference by the cultivator must be difficult and, if made, shall be readily detectable.

4.3 The outlet shall draw its fair share of silt carried by the distributing channel, but shall not be liable to derangement by silt or weeds.

4.4 It shall be possible for the outlet to work efficiently with a small working head.

4.5 The cost of outlet shall not be high.

5. NON-MODULAR OUTLETS

5.1 *Pipe Outlets* — A pipe outlet with exit end of the pipe submerged in water in the water course works as a non-modular outlet. The pipes are placed horizontally and at right angles to the centre line of the distributing channel. Discharge through the pipe outlet is given by the formula:

$$q = CA \sqrt{2 gH}$$

where

C = coefficient of discharge which depends on friction factor, length and size of the pipe outlet;

$$= \frac{1}{2 \times 10^5} \sqrt{\frac{d}{f \left(L + \frac{1.5 d}{400 f} \right)}}$$

f = coefficient of fluid friction for pipes. Its value would be 0.005 and 0.01 for clean and slightly encrusted iron pipes respectively. For earthenware pipes its value can be taken as 0.0075;

L = length of pipe in metres; and

d = diameter of pipe in cm.

5.1.1 The values of C for different fluid friction of outlet pipes shall be as given in Table 1.

TABLE 1 COEFFICIENT OF DISCHARGE FOR DIFFERENT FLUID FRICTION

LENGTH OF THE PIPE	DIAMETER OF PIPE	COEFFICIENT OF DISCHARGE, C	
		$f = 0.005$	$f = 0.01$
(1)	(2)	(3)	(4)
m	cm		
3	10	0.69×10^{-4}	0.609×10^{-4}
	15	0.725×10^{-4}	0.66×10^{-4}
	20	0.745×10^{-4}	0.69×10^{-4}
	25	0.758×10^{-4}	0.711×10^{-4}
5	10	0.653×10^{-4}	0.535×10^{-4}
	15	0.68×10^{-4}	0.594×10^{-4}
	20	0.707×10^{-4}	0.632×10^{-4}
	25	0.725×10^{-4}	0.659×10^{-4}
7	10	0.587×10^{-4}	0.482×10^{-4}
	15	0.641×10^{-4}	0.545×10^{-4}
	20	0.674×10^{-4}	0.587×10^{-4}
	25	0.697×10^{-4}	0.618×10^{-4}
9	10	0.55×10^{-4}	0.443×10^{-4}
	15	0.609×10^{-4}	0.506×10^{-4}
	20	0.645×10^{-4}	0.55×10^{-4}
	25	0.671×10^{-4}	0.583×10^{-4}
12	10	0.506×10^{-4}	0.398×10^{-4}
	15	0.567×10^{-4}	0.461×10^{-4}
	20	0.609×10^{-4}	0.506×10^{-4}
	25	0.638×10^{-4}	0.541×10^{-4}
15	10	0.472×10^{-4}	0.365×10^{-4}
	15	0.535×10^{-4}	0.425×10^{-4}
	20	0.577×10^{-4}	0.472×10^{-4}
	25	0.609×10^{-4}	0.506×10^{-4}

5.1.2 The discharges for different heads are listed in Table 2.

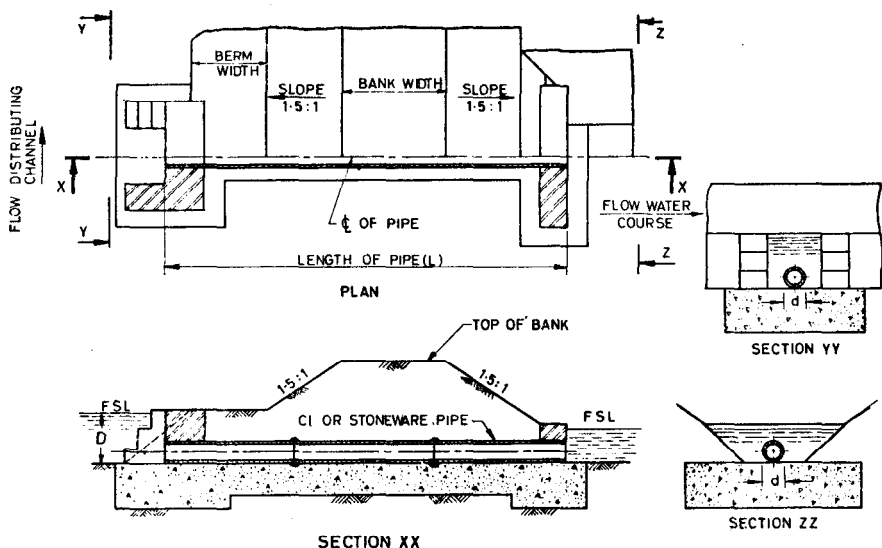
TABLE 2 DISCHARGES FOR DIFFERENT HEADS

COEFFICIENT OF FRICTION $f = 0.01$

LENGTH OF THE PIPE m	DIAMETER OF PIPES cm	DISCHARGE q IN CUMECs $\times 10^{-4}$ for H					
		0.20 m	0.30 m	0.40 m	0.50 m	0.75 m	1.0 m
3	10	0.009 5	0.011 6	0.013 4	0.015 0	0.018 4	0.021 2
	15	0.023 1	0.028 3	0.032 7	0.036 5	0.044 8	0.051 6
	20	0.043 0	0.052 5	0.060 7	0.067 9	0.083 0	0.096 0
	25	0.069 0	0.084 4	0.097 7	0.109 2	0.134 0	0.154 4
5	10	0.008 3	0.010 2	0.011 8	0.013 2	0.016 0	0.018 6
	15	0.020 8	0.025 5	0.029 4	0.032 9	0.040 2	0.046 5
	20	0.039 4	0.048 0	0.055 6	0.062 0	0.076 0	0.087 9
	25	0.064 1	0.078 3	0.090 6	0.101 3	0.123 9	0.143 3
7	10	0.007 47	0.009 16	0.010 6	0.011 9	0.014 5	0.016 8
	15	0.019 1	0.023 4	0.027 0	0.030 2	0.037 1	0.042 6
	20	0.036 5	0.044 6	0.051 6	0.057 6	0.070 6	0.081 6
	25	0.060 1	0.073 4	0.084 9	0.095 0	0.116 2	0.134 4
9	10	0.006 86	0.008 42	0.009 74	0.010 9	0.013 4	0.015 4
	15	0.017 7	0.021 7	0.025 0	0.028 0	0.034 3	0.039 6
	20	0.034 2	0.041 8	0.048 3	0.054 1	0.062 3	0.076 4
	25	0.056 7	0.069 3	0.080 2	0.089 6	0.109 6	0.126 8
12	10	0.006 17	0.007 56	0.008 76	0.009 8	0.012 0	0.013 9
	15	0.016 1	0.019 8	0.022 8	0.025 5	0.031 3	0.036 0
	20	0.031 5	0.038 5	0.044 5	0.049 7	0.060 9	0.070 4
	25	0.052 6	0.064 4	0.074 4	0.083 2	0.101 7	0.117 7
15	10	0.005 66	0.006 94	0.008 03	0.009 0	0.011 0	0.012 7
	15	0.014 9	0.018 2	0.021 0	0.023 5	0.028 8	0.033 3
	20	0.029 4	0.035 9	0.041 5	0.046 4	0.056 8	0.065 7
	25	0.049 2	0.060 1	0.069 6	0.077 8	0.095 0	0.110 1

5.2 It is a common practice to place the pipe at the bed of the distributing channel to enable the outlets to draw fair share of silt charge. The inlet and exit ends of pipe should be preferably fixed in masonry to prevent tampering. Typical layout of this class of outlet is shown in Fig. 1.

5.3 Pipe outlets are adopted in the initial stage of distribution or for additional irrigation in a season when spare supply is available.



NOTE — Where necessary suitable pitching may be provided at the down-stream of the pipe outlet.

FIG. 1 PIPE OUTLET

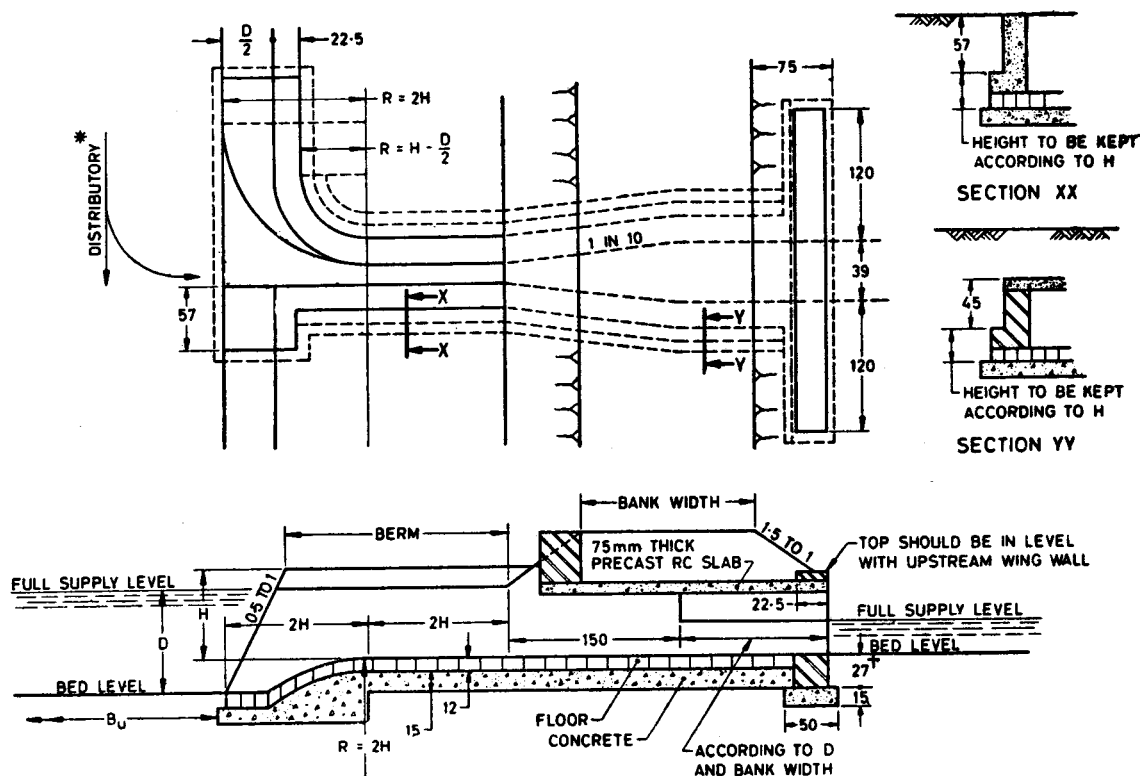
5.4 The discharge in this class of outlets can be increased by deepening the water course and thereby lowering the water surface level in it. The discharge varies from outlet to outlet because of flow conditions and also at different time on the same outlet due to silt charge in the distributing channel.

5.5 These are serious drawbacks in this class of outlets.

6. SEMI-MODULAR OUTLETS

6.1 Pipe Outlets — The pipe outlets described in 5.1 work as semi-modules when the discharge has free fall into the water course. This class of outlets may therefore be used as semi-modular outlets in which case the exit end of pipe is placed higher than the water level in the water course. In this case working head H is the difference between water level in distributing channel and centre of pipe outlet.

6.2 Open Flume Outlets — The open flume outlet is simply a smooth weir with a throat constricted sufficiently to ensure velocity above critical and long enough to ensure that the controlling section remains within the parallel throat at all discharges up to the maximum. A gradually expanded flume is provided at the outfall to obtain the maximum recovery of head. The entire work is built in brick masonry but the controlling section is generally provided with cast iron or steel bed and check plates (see Fig. 2 and Fig. 3).

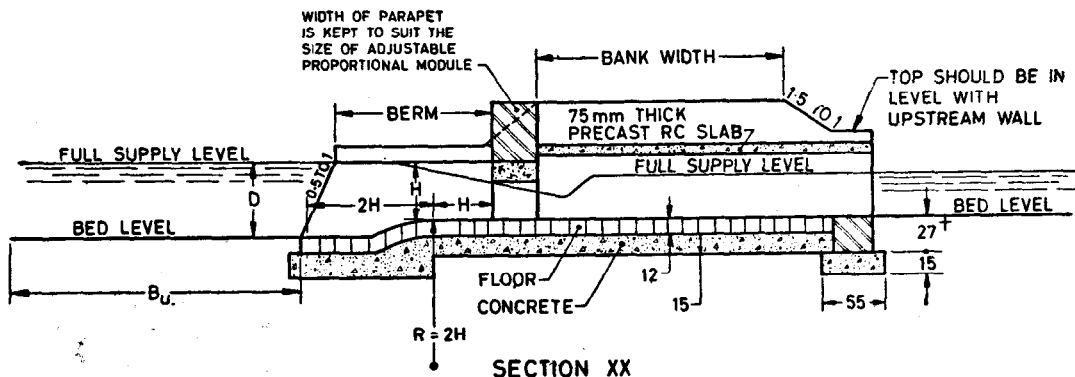
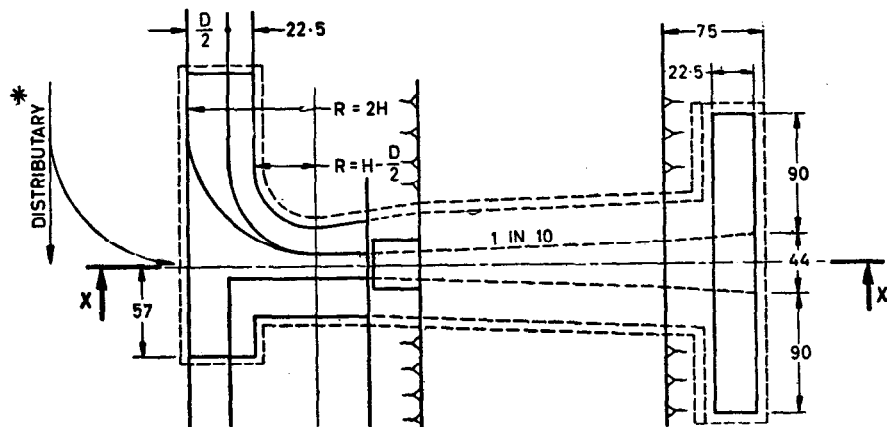


*Where bed width of channel is reduced below outlet downstream wing wall should be at downstream toe of slope and upstream wing at upstream toe of slope

†Where bed of water course is lower than floor of outlet downstream curtain and wing walls to be taken down 30 cm below bed of water course and if necessary a cistern to be provided

All dimensions in centimetres.

FIG. 2 TYPE PLAN OF OPEN FLUME OUTLET FOR DISTRIBUTARY ABOVE 0.6 m DEPTH AND H IS LESS THAN FULL SUPPLY DEPTH



*Where bed width of distributary reduced below outlet downstream wing wall should be at downstream toe of slope and upstream wing at upstream toe of slope

†Where bed of water course is lower than floor of outlet downstream curtain and wing walls to be taken down 30 cm below bed of water course and if necessary a cistern to be provided

All dimensions in centimetres.

FIG. 3 TYPE PLAN OF OPEN FLUME OUTLET WITH ROOF BLOCK

6.3 Crump's Adjustable Proportional Module (Crump's A. P. M.)—

This type is the most commonly used outlet under this class. In this type of outlet, C. I. base, C. I. roof block and check plates on either side form the nucleus around which masonry is built. The roof block is fixed to the check plates by bolts which can be removed and depth of the outlet adjusted after the masonry is dismantled. This type of outlet cannot be easily tampered with and at the same time can be conveniently adjusted at a very small cost. Typical layout of this type of outlet is shown in Fig. 4.

$$W = k \frac{q}{Q} (B_u + D/2)$$

Q (cumecs)	k
Below 0.283	1.00
Over 0.283 and up to 1.415	1.25
Over 1.415 and up to 5.660	1.50
Over 5.660	2.00

6.3.1 The discharge in this type of outlet is given by the formula:

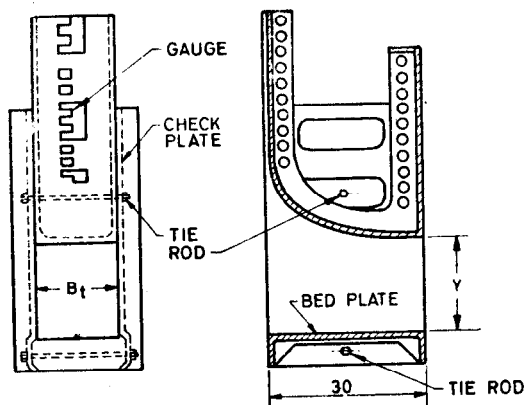
$$q = 4.03 B_t Y \sqrt{H}$$

a) Ratio $\frac{H_s}{D}$ should be between 0.375 to 0.48 for proportionate distribution of silt

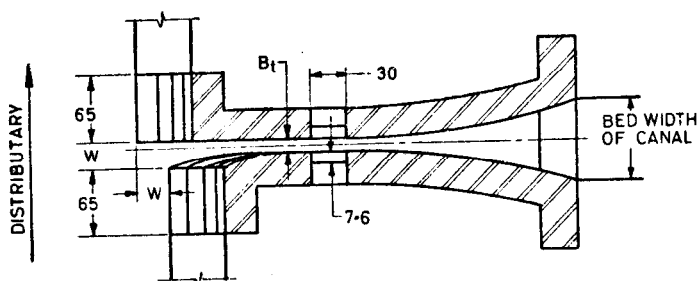
b) Ratio $\frac{H_s}{D}$ should be 0.8 or less for modular working

6.3.2 The base plates and the roof blocks are manufactured in standard sizes, such as $B_t = 6.1, 7.6, 9.9, 12.2, 15.4, 19.5, 24.4$ and 30.5 centimetres. These standard sizes with required opening of the orifice are used to obtain desired supply through the outlet.

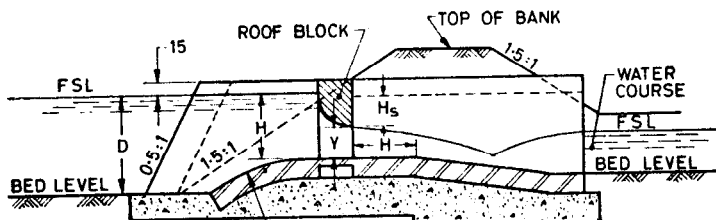
6.4 The waterway in this type of outlets is either deep and narrow which could get blocked easily or is shallow and wide in which case it does not draw its fair share of silt.



DETAILS OF ROOF BLOCK



PLAN



LONGITUDINAL SECTION

All dimensions in centimetres.

FIG. 4 CRUMP'S ADJUSTABLE PROPORTIONAL MODULE

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AMENDMENT NO. 1 JANUARY 1992
TO
IS 7986 : 1976 CODE OF PRACTICE FOR CANAL
OUTLETS

(Page 11, clause 6.3.1, line 2) — Substitute ' $\sqrt{H_s}$ ' for ' \sqrt{H} '

(RVD 13)